2019 ACS Annual Surgical Simulation Summit:  
An International Multi-Professional Meeting 
Chicago, IL  
March 15-16, 2019

POSTER ROUNDS
Poster Rounds Session Group A
Alexander Perez, MD, FACS moderated Group A
(in order of appearance)
Resident Opinions of the Value and Optimal Content of a Technical Skills Curriculum Using Simulation

Robert Naples, DO, Judith French, PhD, Ajita Prabhu, MD, and Jeremy Lipman, MD
Department of General Surgery

Background

The operative experience of general surgery training has transformed with the advent of laparoscopy and work hour regulations. This has had major implications for residents as there is a shift in technical skills. More emphasis is placed on minimally invasive procedures and less on open. Moreover, the majority of residents are seeking fellowship training upon graduation. A multitude of reasons account for this, but some believe residents do not feel prepared to begin independent practice.

Simulation training is a requirement by the Accreditation Council for Graduate Medical Education (ACGME) and can be used to fill these gaps. Deliberate practice in a safe environment increases confidence and competence with existing and newly acquired skills. This stands to add significantly to the tools in the armamentarium of residency graduates.

To address these challenges, we recently undertook a major revision to our technical skills curriculum. As part of this, we aim to explore the opinions on technical skills training using simulation among general surgery residents at our institution to optimize the utilization of these resources.

Methods

- All 70 eligible general surgery residents (13 preliminary and 57 categorical) participated in the revised technical skills curriculum.
- Following participation an anonymous survey was administered:
  - 19-item questionnaire regarding the optimal use of the simulation lab
  - 10-item anchored Likert scale questionnaire assessing opinions of the technical skills curriculum

Results

- Response rate 26% (18 out of 70)
  - 9 PGY 1, 2, and professional development
  - 9 PGY 3, 4, and 5
  - 14 planning fellowship, 4 undecided

**Should there be mandatory time for skills training?**

- 95% No
- 5% Yes

**Do you utilize the simulation lab independently?**

- 67% Yes
- 33% No

**Why not use the simulation lab independently?**

- Lack of time
- Would utilize if given protected time

Conclusion

- Residents believe the optimal technical skills curriculum using simulation should utilize cadaveric and live animal models directed at specific general surgery skills.
- Protected time will enhance resident independent practice outside of the required curriculum.
- Overall, simulation is beneficial and can enhance skills.

References

5. ACGME, ACGME Program Requirements for Graduate Medical Education in General Surgery. Chicago, IL: ACGME; 2018.
Introduction

- General Surgery training covers a broad spectrum of pathologies and procedures.
- Residents need enough clinical exposure to burn patient management.1 2
- There is a need for new educational solutions to fill this gap.2
- Previous studies have demonstrated the effectiveness of simulation-based education in general surgery training.3 5
- To measure the effectiveness of the training, we are using a structured mock oral board session.

Hypothesis

- Mock oral boards with components of ACGME milestones6 may be an effective assessment tool in evaluating resident performance.

Methods

- We are currently validating mock oral boards as an assessment tool in an educational intervention study.
- Our prospective study includes general surgery residents from PGY 1 to 5 (N=22) as participants (Figure 1).
- Mock oral boards are used as assessment tools for the pretest to determine the baseline knowledge of the participants.

After pretest, the participants are randomly divided into two groups.
- Group one attends a lecture-based session delivered by a trauma surgeon.
- Group two participates in a simulation session followed by expert debriefing.

Both the groups will take an oral board examination and their performance will be scored using our evaluation sheet.

Discussion

- Scoring tools have been developed to minimize subjectivity.
- This unique assessment technique provides the residents another opportunity to prepare for oral board examinations as well as impart cognitive aspects of learning.
- We propose the use of mock orals as an assessment tool for simulation-based training of general surgery residents.

References

Using 3-D Anatomy Models Facilitates Cross-sectional Radiological Learning for Surgery Residents: a randomized controlled crossover trial

Francisco J. Cardenas M.D.¹, Nimesh D. Naik M.D.¹, Eduardo F. Abbott M.D.¹, David Farley M.D.¹
¹ Department of Surgery, College of Medicine, Mayo Clinic, Rochester, MN
² Department of Internal Medicine, Pontificia Universidad Católica de Chile, Santiago, Chile

Mayo Clinic, Rochester, MN

Introduction

General Surgery trainees are expected to interpret cross-sectional radiologic imaging studies. Instruction and education often occur during training. The benefit of 3-Dimensional (3D) anatomical models on radiology education has not been completely clarified. Further research is necessary to assess the learner’s retention of radiology learning with the use of 3D anatomical models in combination with lectures.

Objective

The aim of this study is to evaluate the impact of radiological anatomy lectures and the benefit of incorporating 3D models.

Hypothesis

The utilization of 3D anatomical models in conjunction with a series of focused radiological anatomy interactive lectures improves learners understanding on the topic.

Methods

A randomized controlled crossover trial of 28 general surgery interns was conducted. The participants were given an image-based radiological anatomy test (baseline test) with 52 questions and later randomized into two groups (A and B). Both groups were exposed to a series of six 40-minute teaching sessions on focused radiological anatomy. Each session consisted of pre and post-session quizzes (immediate tests) with 5 questions each, a 20-minute lecture, and a 10-minute exposure to either 3D anatomical models or surgical-skills tasks (SST).

During the first three sessions, Group A (n=14) and Group B (n=14) were exposed to 3D models and surgical-skills tasks, respectively; the groups crossed over for the last three sessions. The same test (post-test) was administered 1 week after the last session and 6 months later (Retention test).

28 PGY-1 General Surgery Residents

- Baseline test
- Group A n=14
- Group B n=14
- 3 sessions Surgical Skills
- 3 sessions 3D models
- 3 sessions Surgical Skills
- 3 sessions 3D models
- Post-test Retention test

Results

Baseline radiological anatomy knowledge was similar between Group A and B (Mean=81±17.5, MeanB=81±20.8, p=0.71), both groups improved their Post-test scores (Mean=64±13.5, p<0.001 and 65±17.2, p<0.007, respectively).

Immediate tests’ scores

<table>
<thead>
<tr>
<th></th>
<th>Pre-session 3D</th>
<th>Pre-session Surgical Skills</th>
<th>Post-session 3D</th>
<th>Post-session Surgical Skills</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdom. Val.</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Abdom. Visc.</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Liver</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Pancreas</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Colon</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Thorax</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

Participants exposed to 3D models and participants performing surgical-skills tasks obtained similar immediate test scores session by session.

<table>
<thead>
<tr>
<th>Improvement by session</th>
<th>Session</th>
<th>3D (%)</th>
<th>p-value</th>
<th>SST (%)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal Wall</td>
<td></td>
<td>0.01*</td>
<td>20</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Abdominal Visc.</td>
<td>14</td>
<td>0.04*</td>
<td>12</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Liver</td>
<td>36</td>
<td>0.04*</td>
<td>43</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td>16</td>
<td>0.08</td>
<td>14</td>
<td>0.18</td>
<td></td>
</tr>
<tr>
<td>Colon/Lower Extremity</td>
<td>58</td>
<td>0.01*</td>
<td>66</td>
<td>0.01*</td>
<td></td>
</tr>
<tr>
<td>Thorax Up. Extremity</td>
<td>28</td>
<td>0.03*</td>
<td>16</td>
<td>0.19</td>
<td></td>
</tr>
</tbody>
</table>

Overall scores in their pre (Mean=52±32 and 54±30, p=0.736, respectively) and post-session quizzes (Mean=83±22 and 82±22, p=0.894, respectively) were not different.

Discussion

Others have shown use of several learning tools and spaced sessions improves cross-sectional anatomical comprehension; such efforts have been readily accepted by learners.

Although the engagement by our residents was not formally measured, positive acceptance was reflected in weekly surveys. The different components of these sessions helped target learner’s needs in a more integrated way.

Both groups A and B showed vast improvement in the final post-test and evident retention after 6 months. Our educational efforts were useful but the benefit of using 3D models was not evident.

This pilot was small and likely underpowered. Additionally, bias in resident’s clinical rotations, medical background, education, personal interest in radiology, attendance at lectures, etc. likely was present in this study and could have affected outcomes.

Conclusions

While integrating 3D anatomical models to assist with comprehension of cross-sectional images showed no additional benefit in this small pilot study, implementation of interactive 2D minute lectures is an effective method to enhance PGY-1 residents’ overall radiological scoring with immediate tests, overall post-test, and retention tests.

References

Laparoscopic Port-Placement: It’s All About The Fundamentals

Nimesh D. Naik M.D.* Francisco J. Cardenas Lara M.D.* Eduardo F. Abbott M.D.* David R. Farley M.D.† and Travis J. McKenzie, M.D.*

*Department of Surgery, College of Medicine, Mayo Clinic, Rochester, MN
†Multidisciplinary Simulation Center, Mayo Clinic, Rochester, MN

Mayo Clinic, Rochester, MN

Background

Successful laparoscopic surgeons depend on optimal port placement. The concepts of triangulation, distance to the target organ and between our trocars, require mastery to obtain optimal port placement.

Developing a routine that includes palpation of anatomical landmarks and following a sequence when inserting the trocars, also play an important role in the process of achieving a safe laparoscopic operation with the minimal number of trocar insertion attempts.

Evaluation of the understanding and application of these concepts in clinical practice by General Surgery (GS) residents has not been described in the literature.

Many trainees memorize port placement locations for various laparoscopic surgeries (e.g., cholecystectomy, appendectomy, etc.), but when tasked with unique procedures or anatomical variants, the concepts of port placement become essential.

Methods

Utilizing a low-fidelity model of the abdomen with predefined port-entry sites, participants were tested on four simulated scenarios. This evaluation occurred twice within the academic year.

Our primary outcomes included total score and its improvement between the baseline and post-intervention tasks. Secondary outcomes were correct performance on routine tasks (positioning and palpation of anatomical landmarks), port-location, and quiz score.

Methods (cont.)

Participants were required to verbalize patient positioning, palpate relevant anatomical landmarks, and commit to port-placement of camera and working trocars. They were given 90 seconds to complete a five question quiz.

An educational video with fundamental port-placement concepts was distributed to all the participants after the baseline assessment and the residents were released 6 months apart.

Results

Table 1: Tests scores

<table>
<thead>
<tr>
<th>Tests scores</th>
<th>Baseline</th>
<th>Re-test scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score</td>
<td>17.6</td>
<td>27.9</td>
</tr>
<tr>
<td>Routine tasks</td>
<td>8.2</td>
<td>12.5</td>
</tr>
<tr>
<td>Port-location</td>
<td>6.6</td>
<td>10.4</td>
</tr>
<tr>
<td>Quiz</td>
<td>3</td>
<td>5.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score improvement after 6 months</th>
<th>Junior</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Video</td>
<td>10.3</td>
<td>4.9</td>
</tr>
<tr>
<td>No video</td>
<td>5.5</td>
<td>4.6</td>
</tr>
<tr>
<td>Total score</td>
<td>4.4</td>
<td>3.5</td>
</tr>
<tr>
<td>Routine tasks</td>
<td>2.8</td>
<td>4</td>
</tr>
<tr>
<td>Port-location</td>
<td>3.7</td>
<td>1.3</td>
</tr>
<tr>
<td>Quiz</td>
<td>1.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Conclusions

An instructional video for learners pertaining to the concepts of port-placement is an effective way to educate and improve assessment scores.

The lack of improvement on port-location scores seen in the senior residents may represent memorization of the port-location for the given target organs, however, it was demonstrated that their concept understanding improved according to our evaluation.

Agicipation of these concepts in clinical practice remains to be tested.

References

Brand Safe Area: The upper title banner section of the poster provides a brand safe area for the logo, title and author/affiliation text. No photos, illustrations, patterns, high-contrast backgrounds, or graphics are allowed within this area. A logo representing another non-Mayo listed contributing affiliation may be placed in upper right corner within green guideline space.

Poster Body Area: Research text, figures, tables and graphs should appear within this area. No photos, illustrations, patterns, high-contrast backgrounds, or graphics are allowed in the margins. Use the text boxes in the template when possible.
Does Variability Among Surgical Skills Diminish Throughout Residency Training? Analysis of a 5-Task Simulation Curriculum Starting Day 1

Jessica Limberg MD, Aleksandrs Karnick MPH, Victoria Aveson MD, David Fehling MA, Thomas J. Fahey III, MD

Background

- Surgical simulation, such as Fundamentals of Laparoscopic Surgery (FLS), has been shown to improve operative performance.
- However, simulation curriculums are not standardized amongst surgical programs.
- Our aim was to institute a 5-task curriculum to improve and assess surgical technical skills longitudinally during internship.

Methods

- Tasks completed by 1st-year surgical residents:
  - Suturing
  - Knot Tying
  - Vascular Anastomosis
  - FLS PEG Transfer
  - FLS Intracorporeal Suturing
- Prior to the initial assessment, participants watched a demonstrative video outlining each task.
- The point-based scoring system was generated from successful completion of task components.
- Assessments occurred just before residency, mid-year and at the end of the academic year.

Results

- Figure 1. Participant demographics.
  - Female: 5 (26.3%)
  - Intern Type:
    - Categorical: 8 (42.1%)
    - Non-designated Prelimin: 2 (10.5%)
    - plastics: 2 (10.5%)
    - Urology: 4 (21.2%)
    - Interventional Radiology: 3 (15.8%)
  - Completed 3 Core Rotation Prior to Mid-Year Assessment: 18 (94.7%)

- Figure 2. FLS-PEG Completion Time by Session

- Figure 3. Task Improvement Over Time

- Figure 4. Variance of Knot Tying Scores amongst Each Intern Designation

Conclusions

- 1st-year residents showed improvement in each task over periodic assessments during their first year.
- As residents were exposed to the same surgical training, the variability among their surgical skills diminished.
- Instituting a standardized curriculum at the start intern year allows for early supplementation of surgical skills training and longitudinal assessments of involved residents.

References

Training Multidisciplinary Teams in Nontechnical Skills and OR Safety Using Simulation Based Training

Katherine Jackson1, Farishta Nezomuddin2, Wendy Bernstein1, Ronald Bossert1, Amy Butts1, Ahmed Ghazi3, Patricia James1, Sarah Peyre4, Eric Rynerson1, Derek Wakeman1

1Surgery Department, University of Rochester Medical Center, Rochester, New York
2Anesthesiology Department, University of Rochester Medical Center, Rochester, New York
3Institute of Innovation Education, University of Rochester Medical Center, Rochester, New York
4Department of Surgery, University of Rochester Medical Center, Rochester, New York

Background

Teamwork and communication are invaluable to patient safety and optimization of crisis control in the operating room (OR). While the surgical safety checklist (SSC) has been shown to reduce mortality, its full penetrance into perioperative practice is incomplete at our institution.

We created a simulation model to develop and refine nontechnical skills integral to maintaining patient safety in the OR.

Our hypothesis: OR team simulation training would enhance SSC adherence and improve general perioperative safety attitudes.

Methods

Complete OR teams participated in a simulation program:

- Surgery attending and resident
- Anesthesia attending and resident
- Surgical scrub tech
- Circulating nurse

One case with three stages, each followed by a debrief session.

Scenario utilized high fidelity model to replicate OR case

- Simulation mannequin with real-time vital signs
- 3D printed bleeding model to simulate hemorrhage (intraoperative crisis)
- Real instruments
- Phones with dedicated on-call lab, blood bank and patient family numbers

Incongruences and unexpected events were included to highlight potential pitfalls and demonstrate importance of teamwork and utilization of the SSC.

Investigators moderated debriefing sessions at the end of each stage and at case conclusion. Pre and post simulation surveys were administered.

Participant Characterization:

Breakdown of Participant OR Roles

- Anesthesia team: Attending n=16, Resident n=14
- Surgery team: Attending n=14, Resident n=15
- Nursing team: Nurse n=20, Tech n=5

Participant Experience with OR Simulation

Opinion Regarding Patient Safety as a Priority in their Hospital

(from pre-sim survey)

(from pre-sim survey)

Results

Thoughts expressed during scenario debrief:

Potential Areas of Improvement in the OR:

- Paying attention to the pauses
- Involving all team members
- Employing closed loop communication
- Fostering an empowering environment

Requests to improve OR safety

- Instituting "rapid response team" for the OR
- Central monitoring system

Practice changing?

Of the 80 who responded to the post simulation survey, 69 participants agreed that they would change their practice based on this simulation.

When asked how, they said:

- Better communication (n=18)
- Speak up more (n=15)
- Perform/optimize debrief (n=11)
- Shift their focus/perspective (n=5)
- Include more of the team (n=4)

Survey Responses:

Simulation is an effective way to educate for teamwork in the OR.

My OR team would benefit from simulation and learn from training in the OR.

Performing a surgical sign-out (debrief) AFTER a surgical procedure is important for patient safety.

Conclusion

High fidelity simulation can be used to:

- Strengthen interprofessional teamwork
- Enhance attitudes toward SSC utilization
- Promote awareness of potential communication breakdowns that may jeopardize patient safety.

Future directions:

- More participants
- New scenarios
- Six month follow up survey
- Assessment of debrief frequency and quality long-term

Patient Safety + Simulation
Do Surgery Preparatory Courses (“Boot Camps”) Prepare Graduating Medical Students for Surgical Internship?

John R. Martin, MD, Elizabeth Huffman, MD, Nicholas Anton, MS, Brianne L. Nickel, MA, Dimitrios Stefanidis MD, PhD, Nicole K. Lee, MD, EdM, Jennifer N. Choi, MD
Indiana University School of Medicine, Indianapolis Indiana

BACKGROUND
Medical schools frequently offer intern preparatory courses (“boot camps”) with the goal of better preparing senior medical students for surgical internship. Our aims were to determine the effect of these boot camps on intern readiness at the beginning of intern year using the new American College of Surgeons Entering Resident Readiness Assessment (ACS-ERRA), a “case-based instrument to measure clinical decision-making skills of entering surgical residents”3; and, to assess clinical decision-making two months into intern year using the American College of Surgeons Objective Structured Clinical Exam, a high-fidelity clinical simulation designed to “reliably assess the knowledge and skills of entry-level PGY1 surgery residents to deliver safe care to surgery patients”4.

STUDY DESIGN

![Diagram showing ACS ERRA and OSCE with Boot Camp and No Boot Camp groups]

- **ACS ERRA**
  - **Skills Labs**
  - **Tailored Didactics**
  - **Clinical Duties**

- **ACS OSCE**
  - **Skills Labs**
  - **Tailored Didactics**
  - **Clinical Duties**

**Boot Camp** (n=15)
**No Boot Camp** (n=9)

Spring 2018 → End of June → End of August

After the ACS-ERRA, interns met one-on-one with the Program Director to receive individual feedback on their performance.
After the ACS-OSCE, interns attended group didactics and received individual feedback on ACS-OSCE performance.

METHODS

1. Performance between interns who completed boot camps and those who did not were compared on the ACS-ERRA and ACS-OSCE using Welch’s two-sample t-test. (2.) Pearson correlation was calculated between boot camp participation and ACS-ERRA and ACS-OSCE performance. (3.) Linear and step-wise regression were conducted to determine predictors of intern performance on the ACS-ERRA and the ACS-OSCE using United States Medical Licensing Exam (USMLE) Step I and Step 2 CK scores, boot camp participation, and ACS-ERRA scores as independent variables.

RESULTS

1. Interns who had participated in a boot camp (n=15) performed significantly better on the ACS-ERRA than those who had not (n=9; t(11.9)=2.2, p=0.049) (see box-and-whisker plot at right), but not on the ACS-OSCE.
2. There was a significant positive correlation between boot camp participation and ACS-ERRA score (r = 0.46, p = 0.02), but not between boot camp participation and ACS-OSCE score. Likewise, there were no significant correlations between USMLE scores and ACS-ERRA or ACS-OSCE scores; however, a positive correlation between Step 2 CK and ACS-ERRA score approached significance (see scatterplot at right).
3. Boot camp participation was associated with improved performance on the ACS-ERRA (BBOOTCAMP=0.05, p=0.022, adjusted R²=0.18), but not on the ACS-OSCE.

DISCUSSION
Interns who participated in a boot camp at the end of medical school performed better on average on the ACS-ERRA than those who did not, and after all participants had completed the ACS Fundamentals of Surgical Curriculum, demonstrating at least some benefit of boot camps for new surgical interns. This effect did not extend to the ACS-OSCE administered two months into intern year. Inherent format differences between the ACS-ERRA (written exam) and ACS-OSCE (patient simulation) are a limitation of this study; however, this “leveling” of performance on the ACS-OSCE may reflect significant learning that takes place during the first months of intern year. In other words, boot camp participants may have a slight head start on their peers, but all early interns experience a big climb along their learning curve. Both assessments provided robust individual-level data that was used to identify gaps in clinical performance and provide personalized feedback.

KEY REFERENCES
Poster Rounds Session Group B
John R. Martin, MD moderated Group B
(in order of appearance)
CREATING A MULTIUSE LOW-COST HEMATEMESIS MANNEQUIN

INTRODUCTION

Variceal hemorrhage is an example of the type of medical emergency that requires efficient care provided by a rapid response team (1). Teams must simultaneously ensure hemodynamic stability, airway protection, prevention and treatment of complications, and management of the bleeding. Balloon tamponade is an option for temporarily stopping bleeding from esophageal or gastric bleed while definitive treatment is being arranged (2). Major complications have been observed in approximately 14% of patients, occurring more frequently when tubes were inserted by relatively inexperienced staff (3). Simulation can be used to teach nursing staff to gather the appropriate equipment and to maintain the device after insertion.

Our objective was to create a mannequin to facilitate team-based training and to provide the opportunity to practice responding to this type of high stakes, low frequency emergency in a safe learning environment.

METHODS

To address the need for a specialized mannequin, a multidisciplinary planning team was formed.

- The team identified that the simulator needed to allow faculty to teach medical staff to intubate the patient & to insert and inflate tamponade tubes in the correct order during active bleeding.
- An old Laerdal mannequin was modified and an old IV arm was partially attached.
- Dentists created the upper airway and the esophageal portion of the mannequin.
- A lung bag was used as a bladder for the simulated blood, connected to a water pump, and connected to an ET tube with a mesh on the end to slow down and spread the flow.
- Faculty are able to make the mannequin vomit blood using a remote control.

CONCLUSIONS

To create the level of fidelity necessary, a full body mannequin was built utilizing an old Laerdal mannequin, a rebuilt upper airway and GI tract, a water pump, lung bag and ET tube. The mannequin can be activated via remote control, can be intubated, intravenous fluids can be administered, and a balloon tamponade tube can be inserted and inflated. The trainer can be replicated and at the cost of less than 150.00 USD.

This simulation scenario requires a mannequin that is not commercially available. This simulation will allow us to identify and address gaps in knowledge and skills in a safe learning environment.

BIBLIOGRAPHY

International Collaboration through Simulation in the Health Sciences

Erik Norbie, BA1; Asima Banu, MBBS MD2; Ashis Chand, MCh MS DNB3; Jon Chaika, NREM1; Jane Miller, PhD1; Karyn Baum, MD1; Cheri Friedrich, DNP CPNP-PC1; Mojca Konia, MD PhD1; Kumar Belani, MD1; James Harmon, MD PhD1

1University of Minnesota 1Health Simulation, 2Bangalore Medical College & Research Institute, 3St. John’s Medical College

Background

• An interdisciplinary team from the University of Minnesota’s 1Health Simulation Program (UM) collaborated with the faculty from the Bangalore Medical College & Research Institute (BMCRI) to develop and support a new simulation center in Bangalore, India.

• A four-day workshop was designed and implemented onsite in Bangalore to establish this partnership.

Workshop Objectives

Initiate plans for long-term collaboration
Share best practices in simulation with local leaders
Provide onsite training to faculty and help optimize new space

Methods

• The workshop was designed to cover a range of simulation methodologies and modalities, with content for clinicians, educators, and operation specialists / engineers (Figure 1).

• Among the workshop components, the immersive scenarios included trauma, anaphylaxis, insecticide overdose, and snake bite. Skills training ranged from vascular access to developing performance checklists. Keynote and discussions covered topics such as debriefing skills and scenario development.

Methods Continued

• The use of simulation to support interprofessional training was highlighted throughout the workshop.

• Participants completed surveys after each simulation. These surveys served multiple purposes including: to understand the impact and relevance of the workshop, to demonstrate evaluation methods to BMCRI faculty, and to identify potential center issues prior to launching the new center.

• Surveys (N=178) were analyzed cumulatively and by subgroups.

Workshop Components

• Keynote presentations
• Immersive scenarios
• Skills training
• Round table discussions

Participants

• Clinical faculty
• Residents
• Medical students
• Nursing staff
• Allied health staff

Faculty Hand-off

• Design scenarios
• Co-facilitate simulations
• Lead debriefs
• Establish interprofessional links

Evaluation

• Survey of 12 experience-based items
• 6-point Likert agreement scale
• Qualitative feedback
• Group reflective sessions

Results

• There was strong agreement among participants regarding the overall value of the simulation experiences. All quantitative responses across the workshop's simulation experiences averaged between 4.3 and 5.5 on a 6-point Likert scale (4=Slightly Agree, 5=Agree, 6=Strongly Agree).

• Similar responses were seen within each participant subgroup and simulation scenario type. Mean responses to the trauma simulation (motorcycle accident with hypovolemic shock and increased intracranial pressure) are displayed in Table 1 for three of the survey items.

Table 1. Mean Participant Responses to Trauma Simulation

<table>
<thead>
<tr>
<th></th>
<th>Clinical Faculty (n=20)</th>
<th>Medical Students, Residents (n=33)</th>
<th>Nursing, Allied Health Staff (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel more prepared to manage this kind of clinical situation in the future.</td>
<td>5.2</td>
<td>5.2</td>
<td>5.5</td>
</tr>
<tr>
<td>This experience helped me understand more about interprofessional practice.</td>
<td>5.4</td>
<td>5.1</td>
<td>5.7</td>
</tr>
<tr>
<td>Overall, this was a useful experience.</td>
<td>5.5</td>
<td>5.4</td>
<td>5.7</td>
</tr>
</tbody>
</table>

• Important themes emerging from open-ended survey questions related to “The opportunity to practice effective team communication” and “The opportunity to gain confidence and improve patient care skills.”

Conclusion

• Workshop data indicated enthusiasm and overwhelming support from participants to advance the new center and simulation-based training at BMCRI.

• The enthusiasm among clinical faculty and nursing staff to use simulation for interprofessional team training can inform the role of simulation in BMCRI's curriculum.

• With technologies capable of standardization and novel opportunities for data collection, simulation is uniquely suited to enable international collaboration, including curriculum development and educational research.
Introducing Tattoos to Advanced Trauma Life Support (ATLS): A Process Improvement Initiative

Luis E Llerena1,2, MD, FACS, Andre Nelson3, CHSOS, Johairis Ayal-Walcon4, BS, CHSOS, Michael Brannick1,2, PhD, Lauren Dyer4

1Center for Advanced Medical Learning and Simulation (CAMLS), USF Health, University of South Florida, Tampa, FL
2Department of Surgery, Morton College of Medicine, University of South Florida, Tampa, FL
3Psychology Department, University of South Florida, Tampa, FL
4University of South Florida, Tampa, FL

Background
The Advanced Trauma Life Support® (ATLS®) Course is a continuing medical education activity that provides physicians with a standard approach to trauma care. Participants are required to successfully take both a cognitive exam and a skills assessment to earn an ATLS® certification. The skills assessment involves a supervised evaluation of a learner’s primary and secondary trauma survey on a standardized patient (SP). Our center implemented use of new moulage tattoos in place of standard moulage application. We assessed feedback data regarding the use of moulage tattoos as a process improvement initiative.

Hypothesis
Introduction of the new moulage tattoos would show equivalence in terms of time to set up and total cost as traditional moulage. Users (SPs and Learners) would respond positively to the tattoos.

Methods
To better understand the differences between the new and standard techniques, we compared data from two consecutive 2-Day 9th edition ATLS courses. The two courses were structured in the same manner except for the new moulage technique.

The standard moulage course was completed in July 2018; the new method was completed in September 2018.

Data gathered for our PI initiative included:
- cost of moulage supplies, staff, and SPs
- total time for moulage application to SPs
- total time for staff preparation
- 10 question Likert scaled surveys

Costs included: SP hourly rate, staff hourly rate, and moulage supplies

Surveys were distributed to SPs, the staff applying moulage, the ATLS coordinator, and the ATLS instructors.

Results
- Total cost savings for ATLS Tattoo Moulage was $610.95 (62% savings)
- SP, Staff, ATLS coordinator, and ATLS instructors had an extremely favorable response
- SPs and Learners recommended continued use of the tattoos
- SP mean 4.52/5; Learner mean 4.67/5

None of the moulage required reapplication or adjustment during the skills assessment portion of ATLS testing

Discussion
- ATLS should provide a realistic experience for learners that allows for suspended disbelief
- Standardized moulage tattoos moulage provide a benefit for learners and AEs providing ATLS
- Tattoos can serve a critical role in simulation design
- Further dissemination of this initiative should be undertaken by all AEs that provide ATLS
- All AEs should review courses for ROI and process improvements

Conclusion
Cost containment and resource utilization play a significant part in process improvement in any AEL. This preliminary study describes a new method of moulage application that standardizes the appearance and reduces time and effort in SP preparation, thus increasing consistency and reducing total cost. Future multisite studies should be undertaken to replicate these results and investigate any impact on student performance metrics.

Acknowledgement
We wish to thank Dr. Mark Bower and Dr. Joseph Loprieato from Val G. Heming Simulation Center (USFDS), and Elizabeth Weisbrod from the Henry Jackson Foundation, for providing tattoos and invaluable guidance with the project.
An RCT assessing the rate of decay of VR Colonoscopy skill

Yash Verma\textsuperscript{1*}, Uttaran Datta
\textsuperscript{1}Imperial College London, United Kingdom

**Background**

Psychomotor skills are difficult to learn and have been known to deteriorate over periods of non-use. The rate of decay of such skills is yet to be quantified. This study assessed the rate at which colonoscopy skills and its associated metrics decay over time.

**Hypothesis**

Newly acquired colonoscopy skills will extinguish over a 2 week to 1 month period with non-use. The rate of deterioration should be proportional to the period of non-use.

**Aim**

To train subjects to competency and then assess the decay of their newly acquired colonoscopy skill.

**Introduction**

Colonoscopy is a complex psychomotor task, that requires the amalgamation of motor and sensory skill sets, as well as the use of higher cortical functions. These functions involve attention control, behavioural organisation and gross and fine motor movement. These unique demands make colonoscopy a very difficult skill to master and comparable to other surgical skills a surgeon may need to develop or demonstrate at various stages of their career. Furthermore, once the requisite skills have been acquired, it is not clear how long these skills remain optimal.

**Methods and Materials**

The results showed a significant difference among the three groups ($F_{2,28}=15.08, P=0.0001$). Subjects testing after 2 weeks took more attempts to reach competency than participants that tested the next day with the difference trending towards significance ($t=1.85, P=0.075$).

Subjects testing after a month took significantly more attempts than those that tested the following day ($t=5.42, P=0.0001$) as well as those that tested after 2 weeks ($t=3.42, P=0.002$).

The relationship of these differences was analysed and determined to be linear (difference in mean = 2.49, 95% CI = 1.55 – 3.43, $P=0.0001$).

**Results**

The results showed a significant difference among the three groups ($F_{2,28}=15.08, P=0.0001$). Subjects testing after 2 weeks took more attempts to reach competency than participants that tested the next day with the difference trending towards significance ($t=1.85, P=0.075$).

Subjects testing after a month took significantly more attempts than those that tested the following day ($t=5.42, P=0.0001$) as well as those that tested after 2 weeks ($t=3.42, P=0.002$).

The relationship of these differences was analysed and determined to be linear (difference in mean = 2.49, 95% CI = 1.55 – 3.43, $P=0.0001$).

**Conclusions**

Once acquired, VR colonoscopy skills as demonstrated in this study, appear to show degrees of decline at two weeks with the most significant effects observed at a retention period of one month. The time aspect of the skill is more resistant to decline when compared with the accuracy measures. Despite this study being performed on one type of VR simulator assessing just colonoscopy skill, these findings may be applicable for the planning and structuring of training programs using other modalities and simulators.
Introduction

Multiple new approaches to managing vesicoureteral reflux has resulted in a significant decline in open ureteroneocystotomy. An ability to perform this key urologic procedure is critical for practicing urologists. In many urologic training programs there are an insufficient number of cases available to master the multiple methods of open ureteroneocystotomy. We developed a hands-on high fidelity low cost laboratory practicum to facilitate the development of Urologic residents’ surgical skills in the performance of the most common open ureteral reimplantation operations.

Methods

Porcine bladders with intact ureters/bladders were used as models for various ureteroneocystotomy reimplant techniques. Videos of the operative procedures were created and posted for the residents in advance of the training. On the day of the lab, a brief review of current treatment practices and surgical indications for treatment was provided. Urology residents were taught and then performed the extravesical nondismembered, Cohen Cross Trigonal, extravesical dismembered, and the intravesical Polliano-Leadbetter technique. In addition to these reimplant techniques the residents had additional time to practice other techniques including partial nephrectomy, transureteral ureterostomy, ureterocalycecostomy, Boari flap, psoas hitch, and multiple bladder closures.

Results

<table>
<thead>
<tr>
<th>Table 1: Ureteral Reimplant Lab – Resident Evaluation of Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of residents participating: 14 urology residents, 2 Med3 students</td>
</tr>
<tr>
<td>Number of evaluations received: 16 (100%)</td>
</tr>
<tr>
<td>Learning Objectives:</td>
</tr>
<tr>
<td>1. My learning objectives were not met for this procedure</td>
</tr>
<tr>
<td>Responses: 0</td>
</tr>
<tr>
<td>Technical Demonstration:</td>
</tr>
<tr>
<td>1. Instructor failed to clearly demonstrate the basic principles</td>
</tr>
<tr>
<td>Responses: 1</td>
</tr>
<tr>
<td>Practice:</td>
</tr>
<tr>
<td>1. Received no hands-on practice time</td>
</tr>
<tr>
<td>Responses: 0</td>
</tr>
<tr>
<td>Confidence:</td>
</tr>
<tr>
<td>1. I would not be able to perform the procedure unassisted</td>
</tr>
<tr>
<td>Responses: 1</td>
</tr>
<tr>
<td>Fiduciary of the Model:</td>
</tr>
<tr>
<td>1. Was not the human in any way</td>
</tr>
<tr>
<td>Responses: NA/blank: 3 (18%)</td>
</tr>
</tbody>
</table>

Conclusions

The application of innovative models for the development of surgical skills in the face of declining surgical volume of open ureteral reimplants allows for the acquisition and honing of surgical technique thereby diminishing the surgical learning curve. We will continue this lab and plan to add endoscopic subureteric injection of bulking materials and also to use the model to practice robotic ureteral reimplantation.

Selected References

Validation of a Novel Needle Holder to Train Advanced Laparoscopy Skills to Novices in a Simulator Environment

N. Oussi1,2, K. Georgiou3, A. Larentzakis3, D. Thanassas4, L. Enochsson5

1Department of Clinical Science, Intervention and Technology (CLINTEC), Karolinska Institutet, Stockholm, Sweden, 2Centre for Clinical Research Sörmland, Uppsala University, Sweden, 31st Department of Propaedeutic Surgery, Hippocrateion General Hospital of Athens, Athens Medical School, National and Kapodistrian University of Athens, Greece, 4Medical Physics Lab-Simulation Center (MPLSC), University of Athens, Greece, 5Department of Surgical and Perioperative Sciences, Division of Surgery, Umeå University, Umeå, Sweden

Conclusion

This study shows, a significant improvement and a shortening of the learning curve when novices are training in AL-skills with the NNH compared to the MNH. Our findings suggest that it could be feasible to start early AL training in novices using the NNH. Furthermore, OVEST may be used in an experimental setting as an evaluation tool, comparable with the validated software program of the SB.

Background

Our aim, was to objectively evaluate if a newly designed needle holder (NNH) could shorten the learning curve of novices in advanced laparoscopy (AL) techniques (suturing and knot-tying) compared to a conventional market needle holder (MNH) in a simulator, as well as to validate a new video scoring system to determine AL-skills.

Methods

46 medical students were randomized into identical tasks with either NNH (Laprotech AB, Sweden) or MNH (Karl Storz, Germany) in a prospective, cross-over study evaluating AL-skills (NNH vs MNH). All subjects performed a double-throw knot, two single-throw knots following three running sutures in the Simball box (SB) simulator. After resting, both groups performed the second trial switching NH. All tasks were videotaped and analyzed through both the SB-software and by two independent reviewers, using an Objective Video Evaluation Scoring Table (OVEST), produced by the authors. Performance of the two trials are expressed both as SB overall score (SBSOS) and OVEST.

Results

In both trials: a) OVEST exhibited excellent correlation between the two reviewers (RSquare 0.89 p<0.0001) b) OVEST and SBSOS significantly correlated (RSquare 0.31 p<0.0001, RSquare 0.30 p<0.0002). In the group starting with NNH and followed by MNH, OVEST was consistently high during both trials (12.2±0.8 and 13.3±1.1). However, in the group starting with MNH, OVEST improved significantly when the participants changed to NNH (9.7±1.0 vs 12.7±0.8 p=0.0003) (Figure 1), an improvement also registered by SBSOS (42.2% vs 49.0% p=0.0289).
General Surgery Operative Skills Simulation Curriculum: A Faculty and Resident Needs Assessment

Dickinson K1, Zajac S1, Dunkin BJ1, Basa BL1
1Department of General Surgery and Methodist Institute for Technology, Innovation and Education, Houston Methodist Hospital, Houston, Texas.

**Objective**
To determine how to best utilize the finite simulation facilities to effectively implement the resource intense ACS/APDS operative skills simulation curriculum at our program.

**Background**
Simulation based training is well known to help residents prepare for/consolidate their OR experiences. Simulation resources are finite and a targeted general surgical simulation curriculum is important. Our aims were: 1) to assess preferences of faculty and general surgical residents with regard to entire operations (a resource intense simulation) to include in our general surgical simulation curriculum 2) to assess which resident skills, developed in our longstanding experiential program of learning, could be improved upon at each level of training.

**Methods**
SCORE common essential general surgical operations were sent to all faculty and residents by electronic survey - 12 faculty, 25 residents - 7 PGY4/5, 12 PGY2/3, 6 PGY1. Participants were asked to rate each operation per its value for inclusion in the simulation curriculum using a Likert scale (1=unnecessary, 5=essential). They were asked their top five operations for inclusion in the curriculum. Faculty were also asked about areas in which technical skills could be improved for each level of residency using the OSATS model (objective structured assessment of technical skills).

**Results**
For faculty, laparoscopic cholecystectomy (mean = 4.77), open inguinal/femoral hernia repair (m = 4.62) and small intestinal resection (m = 4.46) were the highest ranked operations. Varicose vein surgery, excision of perianal condylomas and anal sphincterotomy were the lowest. For PGY4/5 residents the highest ranking operation was laparoscopic colectomy (m = 4.77), for PGY2/3 tracheostomy and open colectomy (both m = 4.58) and for interns open inguinal or femoral hernia/lap choles/open splenectomy/ileostomy closure (all m = 5). Faculty identified areas for improvement at each resident level per OSATS are shown in Figure 1.

**Conclusion**
The ACS/APDS operative skills curriculum is comprehensive and valuable. Simulation of operative skills can be resource intense.

The value of this work is that for our program we have identified by PGY level what attendings and residents think is important and provide an opportunity for alignment of goals and learning experiences.

**Figure 1 Faculty identified areas for improvement in technical skills**

![Figure 1 Faculty identified areas for improvement in technical skills](image)

**OSATS criteria rated by faculty**

<table>
<thead>
<tr>
<th>Faculty and Interns</th>
<th>Operation</th>
<th>Weighted mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>Open inguinal/femoral hernia</td>
<td>4.77</td>
</tr>
<tr>
<td></td>
<td>Open inguinal/femoral hernia repair</td>
<td>4.62</td>
</tr>
<tr>
<td></td>
<td>Small intestinal resection</td>
<td>4.46</td>
</tr>
<tr>
<td></td>
<td>Lap appendix</td>
<td>4.31</td>
</tr>
<tr>
<td></td>
<td>Lap ventral hernia</td>
<td>4.23</td>
</tr>
<tr>
<td></td>
<td>Lap choles with or without IOC</td>
<td>4.23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Interns</th>
<th>Operation</th>
<th>Weighted mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open inguinal/femoral hernia</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Open inguinal/femoral hernia repair</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Small intestinal resection</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Lap appendix</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PGY4/5</th>
<th>Operation</th>
<th>Weighted mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lap partial colectomy</td>
<td>4.77</td>
</tr>
<tr>
<td></td>
<td>Ex lap – open</td>
<td>4.71</td>
</tr>
<tr>
<td></td>
<td>Lap inguinal/femoral hernia</td>
<td>4.71</td>
</tr>
<tr>
<td></td>
<td>Lap open splenectomy</td>
<td>4.71</td>
</tr>
<tr>
<td></td>
<td>Open partial colectomy</td>
<td>4.57</td>
</tr>
<tr>
<td></td>
<td>Lap feeding jejunostomy</td>
<td>4.42</td>
</tr>
<tr>
<td></td>
<td>Open ventral hernia</td>
<td>4.28</td>
</tr>
<tr>
<td></td>
<td>Small intestinal Anastomosis</td>
<td>4.28</td>
</tr>
</tbody>
</table>

**Simulation Lab at the Methodist Institute for Technology, Innovation and Education, MITIE.**

Above: Cadaveric lab
Below: Simulation of CBD exploration, dry lab model
INTRODUCTION

*Teamwork in healthcare today is less than ideal.

Tribalism + Rigid Hierarchy = Explosive Mix!

Silo Mentality

*We investigated the impact of introducing a health sciences center-wide, simulation-based, interprofessional team training on senior medical students’ team-based attitudes.

METHODS

*A quasi-experimental design was utilized comparing matched pre-post-training teamwork attitudes collected at the beginning and the end of medical students’ fourth year.

RESULTS

**Participant Breakdown**

Class of 2015: n=58
Class of 2016: n=53
Class of 2017: n=51

**TeamSTEPPS™ Teamwork Attitudes Questionnaire Scores**

**Class of 2013 (n=40)**

<table>
<thead>
<tr>
<th>TeamSTEPPS Subscale</th>
<th>July 2013 Score</th>
<th>April 2013 Score</th>
<th>Matched-paired T-Test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Structure</td>
<td>4.63 (0.27)</td>
<td>4.10 (0.42)</td>
<td>0.17</td>
<td>0.79</td>
</tr>
<tr>
<td>Leadership</td>
<td>4.70 (0.46)</td>
<td>4.10 (0.38)</td>
<td>0.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Situation Monitoring</td>
<td>4.50 (0.46)</td>
<td>4.06 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>Mutual Support</td>
<td>3.96 (0.46)</td>
<td>3.64 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>Communication</td>
<td>4.40 (0.46)</td>
<td>4.10 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Class of 2016 (n=43)**

<table>
<thead>
<tr>
<th>TeamSTEPPS Subscale</th>
<th>July 2016 Score</th>
<th>April 2016 Score</th>
<th>Matched-paired T-Test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Structure</td>
<td>4.80 (0.39)</td>
<td>4.30 (0.42)</td>
<td>0.26</td>
<td>0.49</td>
</tr>
<tr>
<td>Leadership</td>
<td>4.70 (0.46)</td>
<td>4.10 (0.38)</td>
<td>0.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Situation Monitoring</td>
<td>4.50 (0.46)</td>
<td>4.06 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>Mutual Support</td>
<td>3.96 (0.46)</td>
<td>3.64 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>Communication</td>
<td>4.40 (0.46)</td>
<td>4.10 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**Class of 2017 (n=51)**

<table>
<thead>
<tr>
<th>TeamSTEPPS Subscale</th>
<th>July 2017 Score</th>
<th>April 2017 Score</th>
<th>Matched-paired T-Test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Structure</td>
<td>4.80 (0.39)</td>
<td>4.30 (0.42)</td>
<td>0.26</td>
<td>0.49</td>
</tr>
<tr>
<td>Leadership</td>
<td>4.70 (0.46)</td>
<td>4.10 (0.38)</td>
<td>0.50</td>
<td>0.00</td>
</tr>
<tr>
<td>Situation Monitoring</td>
<td>4.50 (0.46)</td>
<td>4.06 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>Mutual Support</td>
<td>3.96 (0.46)</td>
<td>3.64 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
<tr>
<td>Communication</td>
<td>4.40 (0.46)</td>
<td>4.10 (0.46)</td>
<td>0.34</td>
<td>0.01</td>
</tr>
</tbody>
</table>

**CONCLUSION**

*The short term impact of a single high-fidelity, simulation-based, interprofessional team training session on senior medical students’ teamwork attitudes is nuanced.

*Such training may have a limited, positive impact on certain team-based competencies and result in an improving trend related to mean scores from one class to the next.

Funding Source: Health Resources and Services Administration (HRSA), Grant No D3HP20847

School of Nursing, School of Public Health, Department of Surgery, Louisiana State University (LSU) Health New Orleans Health Sciences Center, New Orleans, LA.
EXPERIENCED SURGEONS VERSUS NOVICE RESIDENTS: VALIDATING A NOVEL KNOT TYING SIMULATOR FOR VESSEL LIGATION

INTRODUCTION

Vessel ligation with a knot is one of the most fundamental tasks surgeons must master. We developed a simulator designed to enable novices to experience knot tying with force feedback. Basic surgical simulators with integrated analytical software offer an affordable practice tool to develop and refine performance. Such platforms can be readily accessible to residency programs around the world allowing international standardization, while overcoming financial disparities between training programs.

METHODS

A bench-top knot-tying simulator with computer-aided assessment, “KNOTKIT,” was tested on certified surgeons and surgical residents at a tertiary medical center during the years 2017-2018.

- A. Tying Hook (0.5 cm diameter) connected to a hybrid sensor (Vishay Precision Group, Inc., Micro-Measurements, Malvern, PA, US).
- B. Microcontroller board Arduino Uno (Arduino, Somerville, Massachusetts, US) for data collection.
- C. Acrylic plexiglass removable tube for deep ties simulation.

Dedicated computer software was written using Processing software (Processing, Boston, Massachusetts, US). The simulator measured vertical forces and the time for task completion. Each participant tied a total of eight knots in different settings (superficial vs. deep) and techniques (one-handed vs. two hands). Participants were instructed to avoid tissue rupture or loose knots. All knots were square knots (double-throw knot) using the same type of sutures (SoftV™ 3.0 MEDTRONIC, Minneapolis, Minnesota, US). Statistical analysis was done using Student’s t-test, Mann Whitney or Bonferroni correction.

RESULTS

Fifteen surgeons with 201 years of cumulative surgical experience (13.6 ± 7 years each) and 30 post-graduate year (PGY)-2 surgical residents were recruited for the study.

Experienced surgeons demonstrated:

- Less total force during placement of the knots than the novice residents (5.8 ± 2.0 vs. 9.2 ± 6.1 Newton (N), respectively, p = 0.0005).
- Lower peak force upward (1.31 ± 0.6 vs. 1.75 ± 0.84 N, p = 0.02).
- Shorter time (10.9 ± 3.4 vs. 18.3 ± 7.2 seconds, p=3.4x10^-5).

1.3 N was the average maximum peak force exerted when experts tied a knot with a one-handed technique in a deep setting.

DISCUSSION

Experienced surgeons using KNOTKIT applied less tensile force than novice residents during tying of surgical knots intended to ligate a vessel. This was evidenced by the difference in overall force exerted and in maximal peak upward force, the latter being a critical contributor to tear of knot or avulsion of tissue by inexperienced surgeons exerting superfluous forces. In addition, the forces exerted by the experienced surgeons were more consistent, having become automated, while the novices exhibited a bigger variance of force measurement. The study determined an expert based cut-off for desired forces on our simulator.

CONCLUSION

The simulator can offer residency programs an affordable bench-top platform to objectively train and assess the knot-tying capabilities of surgical residents.

FUTURE RESEARCH

Our future studies will examine how to apply data from the simulator on forces exerted during knot-tying to develop a visual and auditory feedback mechanism. The simulator will become an integral part of our medical center’s surgery boot camp”, to enable interns and residents to practice knot tying with force feedback. It will also be of interest to assess whether skills attained with the improved simulation with feedback are durable and evident weeks and months after practice.

VIDEO

Scan QR code to watch a Video simulation of Knot

ACKNOWLEDGMENT

Aspects of this study were done in collaboration with the Arrow Project, Sheba Medical Center, Tel-Hashomer.

Contact: Roi Anteby, Email: roianteby@mail.tau.ac.il Tel: +19293011120 Faculty of Medicine, Tel Aviv University, Tel Aviv 6997801, Israel
Poster Rounds Session Group C
Ngan Nguyen, PhD, CHSE moderated Group C
(in order of appearance)
How Well do the Neurodynamics of Simulation-based Teamwork Reflect those of Live Patient Encounters?

Ronald Stevens, PhD; Ann Willemsen-Dunlap, PhD; Trysha Galloway, Jamie Gorman, PhD; Donald Halpin, MBA; Julian Lin, MD

UCLA School of Medicine, JUMP Simulation & Education Center, The Learning Chameleon, Inc., The Halpin Group, Georgia Tech, U. Illinois Medical Center

Background
Neurodynamic organization is the tendency of team members to enter into prolonged (minutes) metastable neurodynamic relationships when they experience and resolve uncertainty.

We have used these models to explore whether biometric models of simulated healthcare procedures reflect those of operating room team dynamics.

Methods
Symbolic modeling of EEG can continuously separate quantities of neurodynamic information that are unique to each team member from those shared by the team. This was used to model the team and individual neurodynamics during a peroneal nerve decompression operation.

Comparing the AN’s neurodynamics with simulated and live patient encounters

A. Scenarios

Sim 1 (800 s)

B. Intubations

Sim 2 (967 s)

Evidence for gamma wave suppression (i.e. increased attention) when intubating the live patient

A. Scenarios

Sim 1 (800 s)

B. Intubations

Sim 2 (967 s)

Sensor Differences

Simulation - similar neurodynamic information in the frontal and posterior sensors.

Live Patient - Frontal levels of neurodynamic information were higher than posterior levels.

Operating Room - the Anesthesiologist’s uncertainty arose in the frontal lobes and was associated with decreased gamma waves.

Simulations - the uncertainty was distributed across sensors and frequencies with no gamma suppression.

Frontal brain regions are involved in the detection of unfavorable outcomes, error correction and resolution of uncertainty. Gamma rhythm suppression is associated with better outcomes on complex tasks, we hypothesize that while ventilating the live patient the AN was more attentive and performing finer error detection/correction than when ventilating a mannequin.

Conclusions
As the common measurement unit for each team member and the overall team is the bit, this modeling provides practical objective measures and models to compare performances across teams, training sites, protocols, and simulated vs. live patient environments.

The current studies using this approach suggest that the uncertainty when intubating a live patient induced a greater attentive state in the anesthesiologist than during simulations.

www.teamneurodynamics.com

References

© 2019 The Learning Chameleon, Inc.
Tendon repair (TR) is an advanced, technical surgical skill. Many surgical trainees do not have the opportunity to learn or practice this technique until later in their residency. However, this technique requires practice to achieve the precision needed to perform a strong, durable tendon repair. We aimed to create a cost-effective, realistic, high-quality model for teaching TR outside of the operating room. Since porcine models are readily available to most medical teaching facilities, we chose to evaluate whether the pig’s foot could appropriately serve this purpose.

**Materials and Methods**

**Materials** (Fig. 1)
- Pigs’ foot dissected to expose extensor digitorum lateralis
- 4-0 PDS Suture
- Suturing supplies (Tissue forceps, scissors, needle drivers, and retractors)
- Surveys administered before and after workshop
- Participants were medical trainees from MS2 to MS4 who were unfamiliar with tendon repair technique.
- Modified 2-strand Kessler tendon repair taught using video and in-person diagrammatic instruction

**Results**

**Survey Results**
- 36% increase in familiarity with TR techniques
- 24% increase in confidence in TR ability
- Over 80% satisfaction with porcine model and materials
- Over 80% satisfaction with instruction of suturing technique
- 90% of participants expressed interest in future workshops of similar nature

**Discussion**

- Pre-workshop surveys showed learners may find TR and related surgical techniques intimidating
- Low-cost teaching model was effective in introducing the basics of TR
- Increased learner familiarity and confidence in ability
- Students were satisfied with the porcine model; the same model could be used to teach and practice more complex TR techniques in the future, such as:
  - Using two modified Kessler repairs to obtain 4 core strands in repair
  - Employ a second, epitenon strand to bury knot within the tendon
  - Practice with different sutures, such as a braided permanent suture, which may be encountered in hand surgery
Analysis of General Surgery Intern Performance on Simulation-Based Anatomy Examinations

Abhishek Chandra BA, Courtney Backstrom BS, Fareeda Mukhtar MBBS, Dylan Soukup BS, Aashish Rajesh MBBS, Rafael Azevedo MD, Yazen AlJamel MD, David Farley MD
Department of Surgery
Mayo Clinic, Rochester, MN

Introduction

Our general surgery (GS) residency program developed a low-cost abdominal anatomy simulator and corresponding assessment. This study aimed to analyze the performance of GS interns using this simulation assessment with regards to their knowledge (naming) and spatial understanding (placing).

Methods

- A retrospective analysis of an assessment covering six subtopics with the following points possible: arteries (32), veins (28), portal anatomy (20), solid organs (44), gastrointestinal (GI) structures (42), and nervous system anatomy (12) for a total of 178 points
- 50 GS interns (2017-2019) recreated anatomical relationships and verbalized structures for a pre and post-test assessment taken six months apart
- One point (each) was given for naming and placing structures correctly

Results

- Mean pre-test score: 105; mean post-test score: 126.7 (p<0.05)
- Non-significant increase in naming: organs (diff of 4.1), veins (0.8), portal anatomy (1.7), and GI structures (1.4)
- Non-significant increase in placing: organs (4.0), veins (1.1), portal anatomy (1.7), and GI structures (1.6)
- Non-significant decrease in naming and placing score of nerve anatomy (-0.4, -0.3) or naming of arteries (-0.1)

Conclusions

- An overall improvement in mean scores of anatomy knowledge (naming) was observed
- This low-cost simulation assessment identified topics in abdominal anatomy that may require additional instruction and focus for our interns
- Further study is required to determine the cause of limited performance and improvement between pre and post-testing
Development and Evaluation of a Low-Cost Laparoscopic Cholecystectomy Simulation Model

RU Azevedo MD; A Chandra BA, F Mukhtar MBBS, C Backstrom BS, N Shaikh MBBS, M Baloul MBBS, A Rajesh MBBS, DR Farley MD
Mayo Clinic, Rochester, MN

Introduction

- The formal instruction of both minimally invasive surgical skills and operative insight is challenging
- Simulators like the Fundamentals of Laparoscopic Skills® and Virtual Reality Simulator are often cost prohibitive.
- A low-cost, procedural model may be of great utility in helping learners develop laparoscopic skills and gain procedural insight.

Objective

Develop and assess a low-cost, reproducible, and reusable surgical simulation model for a laparoscopic cholecystectomy (LC)

Methods

- The laparoscopic simulator was built using low-cost materials: fist balloons, memory foam, cardboard, artificial blood, rubber tubing, and Styrofoam
- The LC model was utilized in three Sim sessions; trainees were guided through a lap cholecystectomy by a surgeon.
- Each PGY-1 (n=25) evaluated the model. Survey items inquired about function, hand-eye coordination, and educational value.

Survey: Was this model useful for

- Strongly Agree
- Agree
- N/A
- Disagree
- Strongly disagree

Understanding of procedure: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Depth perception: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Laparoscopic tissue handling: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Dimensions: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Educational engagement: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Anatomy: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Laparoscopic dissection: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Vessel transaction: 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Results

- 96% agreed (n=14) or strongly agreed (n=10) that the low-cost simulator increased their understanding of procedure and its specific considerations
- 96% felt that the simulator effectively tested their depth perception, its dimension and skill with laparoscopic tissue handling
- Feedback was mostly positive regarding the educational engagement (88%) and anatomy (80%)
- When negative feedback was offered, it centered on the model’s inability to reproduce realistic laparoscopic dissection (29%) and vessel transaction (24%)

Conclusions

- This $17.50 replaceable LC model with $0.50 replaceable parts shows promise in supporting general surgery intern acquisition of laparoscopic skills
- Clinical instructors found the model valuable for teaching laparoscopic skills and procedural steps
Introduction

- Review of abdominal surgery during combat from 2002-2016
  - Gynecologic surgery <1% of surgeries in theater
  - Most common gynecologic procedure in theater is cesarean section
  - ACGME does not require competency in cesarean sections prior to graduation from General Surgery residency
  - Obstetric Gynecologists (OBGYNs) are not routinely assigned to operational platforms
  - Urol/gyn procedures afforded
    - Decreased from 40.1 to 6.7 per 7-month deployment over last 20 years
    - Average number of urol/gyn cases for general surgery residents: 0.4 (final year of training) and 4.0 (entire residency)
    - Most common OBGYN procedure done afford is Bartholin’s gland abscess incision and drainage.

- Developed simulation curriculum using low-cost simulation models to address the pressing need for OBGYN procedural training for military general surgery residents.

- Goal: To increase exposure to and confidence in performing commonly encountered OBGYN procedures in a deployed setting (spontaneous vaginal delivery [SVD], Bartholin’s cyst incision and drainage with Word catheter placement, Cesarean delivery [CD], and total abdominal hysterectomy [TAH]).

- Objectives: 1) verbalizes steps of each procedure; 2) demonstrate the ability to perform these procedures on task trainers in the simulation center with proctor feedback; and 3) discuss potential complications and mitigating techniques.

Methods

- A 4-hour simulation-based session for general surgery residents with a targeted lecture followed by proctored skills stations.
- A five-point Likert scale was used to evaluate the learner’s knowledge and confidence levels regarding four OBGYN procedures (SVD, Bartholin’s, CD, and TAH) pre- and post-simulation.
- The Simulation Design Scale (Student version) was used to evaluate the simulation.
- Data were compared with Wilcoxon rank sum test.

![Figure 1. Word Catheter Insertion](image1)

![Figure 2. Total Abdominal Hysterectomy (modified from Greer 2013)](image2)

Results

<table>
<thead>
<tr>
<th>Procedures</th>
<th>Knowledge and Confidence</th>
<th>Mean±SD</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre SM</td>
<td>Post SM</td>
<td></td>
</tr>
<tr>
<td>Bartholin’s</td>
<td>1.45±0.88</td>
<td>2.67±0.94</td>
<td>0.001</td>
</tr>
<tr>
<td>SVD</td>
<td>2.87±0.81</td>
<td>3.67±0.94</td>
<td>0.005</td>
</tr>
<tr>
<td>TAH</td>
<td>1.83±0.90</td>
<td>2.22±1.23</td>
<td>0.001</td>
</tr>
<tr>
<td>CD</td>
<td>1.89±0.87</td>
<td>3.33±1.29</td>
<td>0.007</td>
</tr>
</tbody>
</table>

![Figure 3. Simulation Design Scale Survey Results](image3)

Conclusions

The implemented curriculum increased general surgery residents’ knowledge and confidence in four OBGYN procedures and demonstrated a high level of learner satisfaction. The curriculum can be expanded to other non-OBGYN physicians to enable appropriate OBGYN care in military environment.

References

Feasibility of a Simulation-Based Elective in Robotic and Minimally Invasive Surgery for Medical Students

Sophia H. Roberts, BS, Cole P. Rodman, MA, Jared W. Squires, BA, Joshua H. Conner, BS, Michael P. Meera, MD, MBA, FACS
Department of Surgery, The Ohio State University Wexner Medical Center, 410 W. 10th Avenue, Columbus OH 43210, USA

Purpose

- As robotic surgery has become more widely utilized, many residency programs have incorporated robotic training curricula into their training programs. However, means for practical, sustained exposure to robotic surgery and minimally invasive techniques are lacking for medical students.
- To address this need, we propose a month-long curriculum for fourth-year medical students based on Surgical Entrustable Professional Activities (SEPs) to assess competency in 1) Physical Exam and History-Taking, 2) Content Knowledge, 3) Clinical Reasoning, and 4) Procedural Skill.
- We conducted a feasibility study to determine how long it would take medical students to attain proficiency on the da Vinci robotic simulator to develop this curriculum.

Methods

- 4 medical students attempted all 27 exercises in the da Vinci skills simulator catalog until attaining a passing score ≥ 90%.
- For each exercise, students recorded the attempt number, active simulation time, and percentage attained.
- Results were used to identify exercises that would be appropriate to add to the resident curriculum to make the proposed medical student curriculum.

Surgical Entrustable Professional Activities

<table>
<thead>
<tr>
<th>Physical Exam &amp; History-Taking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct preoperative evaluations in clinic for minimally invasive surgery cholecystectomy, colectomy, inguinal/vaginal hernia repair</td>
</tr>
<tr>
<td>Performance evaluated using CAMERO form</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Content Knowledge &amp; Clinical Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online modules on cholecystectomy, colectomy, and inguinal/vaginal hernia repair</td>
</tr>
<tr>
<td>Case-based oral exam with faculty</td>
</tr>
<tr>
<td>Small group presentation on MIS topic</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedural Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initiative’s online modules for da Vinci Si and Xi systems</td>
</tr>
<tr>
<td>Proficiency in 20 robotic simulator exercises</td>
</tr>
<tr>
<td>Proficiency in 3 laparoscopic exercises</td>
</tr>
</tbody>
</table>

Table 1: Robotic Simulator Performance

<table>
<thead>
<tr>
<th>Skill</th>
<th>Average # Attempts to 90%</th>
<th>Average Time to 90% (sec)</th>
<th>Curriculum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camera Targeting 1</td>
<td>3.8</td>
<td>298.3</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Camera Targeting 2</td>
<td>2.0</td>
<td>248.6</td>
<td>Resident, Medical Student</td>
</tr>
<tr>
<td>Dots &amp; Needles 1</td>
<td>1.5</td>
<td>277.5</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Dots &amp; Needles 2</td>
<td>2.0</td>
<td>390.0</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Energy Dissection 1</td>
<td>4.7</td>
<td>484.3</td>
<td>Resident, Medical Student</td>
</tr>
<tr>
<td>Energy Dissection 2</td>
<td>2.3</td>
<td>230.7</td>
<td>-</td>
</tr>
<tr>
<td>Energy Dissection 3</td>
<td>2.0</td>
<td>197.0</td>
<td>-</td>
</tr>
<tr>
<td>Energy Switching 1</td>
<td>2.3</td>
<td>227.3</td>
<td>-</td>
</tr>
<tr>
<td>Energy Switching 2</td>
<td>1.0</td>
<td>79.3</td>
<td>-</td>
</tr>
<tr>
<td>Match Board 1</td>
<td>4.7</td>
<td>668.7</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Match Board 2</td>
<td>2.5</td>
<td>314.0</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Match Board 3</td>
<td>17.5</td>
<td>4302.5</td>
<td>Resident, Medical Student</td>
</tr>
<tr>
<td>Needle Targeting</td>
<td>1.3</td>
<td>281.3</td>
<td>Resident, Medical Student</td>
</tr>
<tr>
<td>Peg Board 1</td>
<td>3.7</td>
<td>237.3</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Peg Board 2</td>
<td>1.3</td>
<td>133.7</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Pick &amp; Place</td>
<td>2.0</td>
<td>95.8</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Ring and Roll 1</td>
<td>1.0</td>
<td>49.2</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Ring and Roll 2</td>
<td>2.5</td>
<td>645.0</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Ring Walk 1</td>
<td>1.3</td>
<td>71.3</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Ring Walk 2</td>
<td>5.0</td>
<td>727.7</td>
<td>Resident, Medical Student</td>
</tr>
<tr>
<td>Ring Walk 3</td>
<td>12.5</td>
<td>2403.0</td>
<td>-</td>
</tr>
<tr>
<td>Suture Sponges 1</td>
<td>4.7</td>
<td>1224.3</td>
<td>Resident, Medical Student</td>
</tr>
<tr>
<td>Suture Sponges 2</td>
<td>2.7</td>
<td>709.3</td>
<td>Resident, Medical Student</td>
</tr>
<tr>
<td>Suture Sponges 3</td>
<td>2.5</td>
<td>747.0</td>
<td>Resident, Medical Student</td>
</tr>
<tr>
<td>Tissue Suturing</td>
<td>3.7</td>
<td>585.0</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Tubes</td>
<td>2.0</td>
<td>513.0</td>
<td>Medical Student</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td>95.3</td>
<td>4.7 Hours</td>
</tr>
</tbody>
</table>

Table 2: Robotic Simulator Performance by Curriculum

<table>
<thead>
<tr>
<th>Curriculum</th>
<th># Exercises</th>
<th>Avg. # Atts to 90%</th>
<th>Avg Time to 90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resident Curriculum</td>
<td>7</td>
<td>39.0</td>
<td>2.3 hours</td>
</tr>
<tr>
<td>Entire Catalog</td>
<td>27</td>
<td>95.3</td>
<td>4.7 hours</td>
</tr>
<tr>
<td>Medical Student Curriculum</td>
<td>20</td>
<td>70.9</td>
<td>3.5 hours</td>
</tr>
</tbody>
</table>

Discussion

- To attain technical proficiency on the robotic simulator, students required an average 3.5 hours of active simulation time, which should conservatively be doubled to reflect how long a student would need to be physically present at the simulator.
- This set of 20 robotic simulator exercises will be combined with three exercises from the established Fundamentals of Laparoscopic Surgery curriculum to complete the Procedure Skill area of competency.
- Our curriculum is divided into three primary SEPs for cholecystectomy, colectomy, and inguinal/vaginal hernia repair.
- With this infrastructure in place, other SEPs could be made for operations used in other specialties such as Urology, Thoracic Surgery, and Gynecology.
- This course has been approved by The Ohio State University College of Medicine to be launched in August 2019.

Conclusions

- Medical students can attain proficiency in an expanded curriculum of robotic simulation exercises in an amount of time that is appropriate for a month-long elective.

References

Implementation of the Structured Training for Endovascular Techniques (STENT) Curriculum

Morgan L. Cox, MD, MHS; Brian Gilmore, MD; Neena Pack, PA, MHS; Uttara Nag, MD; Brandon Henry, MD, MPH; Ranjan Sudan, MD; John Migaly, MD; Chandler Long, MD

INTRODUCTION
- Competency in minimally invasive techniques (FLS, FES) is a requirement in general surgery training
- Catheter-based techniques are increasingly required in multiple surgical subspecialties
- General surgery programs have not integrated catheter skills

OBJECTIVES
- Gauge interest of general surgery residents in the addition of endovascular skills and catheter skills to general surgery residency
- Develop a basic endovascular curriculum consisting of
  - Written content
  - Simulator experience
  - Early hands-on performance
- Analyze early qualitative data following implementation

METHODS
- Setting: Single, academic medical center
- Interest Survey:
  - 32 questions
  - Distributed to 48 general surgery residents
  - Spring 2017
- Curriculum:
  - Developed didactic curriculum with faculty
  - Obtained simulator, defined core curriculum
  - Implemented as part of endoluminal rotation for junior residents in AF2018-19
- Early Data:
  - Demographics and prior endovascular experience
  - Pre- and post-surveys

SURVEY RESULTS
- 24 residents participated in the survey (50%)
  - 87.5% interested in endovascular training
  - 75% in favor of adding angiography experience to the existing endoscopic rotation (CVSZ)
  - Majority of interest in central venous access, peripheral angiography, and catheter selection

CURRICULUM
- Unique endovascular question bank
  - 20 question pre-test
  - 20 question post-test
- Skills assessment
  - Basic endovascular skills modules 1-4
  - Pre- and post-tests on ANGIO Mentor Flex
- Written content
  - Needles, guidewires, catheters, sheaths
  - Balloons, stents, stent grafts
  - Obtaining access
  - Preparing the OR
  - Radiation Safety
  - Basic Procedures
- One-on-one simulator practice
  - Vascular surgery attending coaching one day per week in simulator lab
- Hands-on experience
  - Weekly assignments to endovascular cases
  - Resident works directly with attending in both OR and cath lab

EARLY EXPERIENCE

<table>
<thead>
<tr>
<th></th>
<th>Pre-Survey</th>
<th>Post-Survey</th>
<th>Mean Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understanding of:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endovascular devices</td>
<td>1.75</td>
<td>2.75</td>
<td></td>
</tr>
<tr>
<td>Obtaining femoral access</td>
<td>1.50</td>
<td>3.50</td>
<td></td>
</tr>
<tr>
<td>Performing diagnostic angiography</td>
<td>1.50</td>
<td>3.25</td>
<td></td>
</tr>
<tr>
<td>Comfort level with:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endovascular devices</td>
<td>1.00</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>Obtaining femoral access</td>
<td>1.50</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>Performing diagnostic angiography</td>
<td>1.00</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>Satisfaction with endovascular training</td>
<td>1.25</td>
<td>4.00</td>
<td></td>
</tr>
</tbody>
</table>

*All survey questions were answered on a 5-point Likert scale

CONCLUSION
- Majority of residents were very interested in endovascular training during general surgery residency
- STENT leads to better understanding of catheter-based procedures by junior residents
- This novel and comprehensive endovascular curriculum increased resident satisfaction with endovascular training
- STENT provides a foundation of knowledge that can be built upon for senior residents

FUTURE DIRECTIONS
- Competency-based structure to set the stage for a national, standardized curriculum
- Video content
- Intermediate curriculum for senior residents

Disclosures: Duke University negotiated with 3D Systems to purchase the Simbionix ANGIO Mentor Flex

Correspondence: morgan.cox@duke.edu
Development of a Laparoscopic Trocar Placement Simulation Model: A Preliminary Evaluation
Edward Walczak B.S., Jillian Schommer B.S., Zachary Miller B.S., Tu Tran B.S., Zac Novaczky B.S., Brian Swisz PhD, Andrew Cleland MD, Victor Yukayil MD, Daniel Leslie MD FACS, James Harmon Jr MD PhD FACS
Department of Surgery, University of Minnesota Medical School

Background

Laparoscopic Trocar (LT)
- Means of gaining access to intraperitoneal space and delivering laparoscopic instruments
- Proper placement is crucial for high-quality laparoscopic surgery
- Improper placement/insertion carries potential for injury to abdominal organs
- Lack of high-quality simulation options for experience before the operating room

Model Development
1. Adapt 3-layer synthetic central-line placement model (abdominal wall)
2. Laparoscopic training box (peritoneal cavity)
3. Laparoscope with video monitor
4. Concentric circle paper-target
5. Metal probe
6. Laparoscopic trocar

Methods

Trial Investigation: Trocar Insertion With and Without Laparoscope Assistance
- Initial testing of model viability
- Assessment of model's investigative utility
- Adaptability to different investigations

Results

<table>
<thead>
<tr>
<th></th>
<th>Mean Distance from Center</th>
<th>Mean Improvement (Assistant &gt;&gt; No Assistant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laparoscope Assistant</td>
<td>6.0 ± 0.7 cm</td>
<td>1.7 ± 0.9</td>
</tr>
<tr>
<td>No Laparoscope</td>
<td>6.8 ± 0.5 cm</td>
<td></td>
</tr>
</tbody>
</table>

Accuracy of Placement With vs Without Laparoscope Assistant
1. Insert LT aiming for target center
2. Run probe through port until contact is made
3. Measure distance from point of contact to center of target.

Future Goals (I) – Trial Investigation
- Repeat study with larger sample size
- Investigate experienced cohort (i.e. residents, staff physicians; compare to preferred technique in OR)

Future Goals (II) – LT Model
- Examine other laparoscopic questions (assisted vs unassisted dissection; porcine vs synthetic abdominal wall)
- Further refine and improve model itself (dummy organs; SMART Trocar)
- Begin use in surgical curriculum

Acknowledgements
University of Minnesota Academic Health Center (AHC) Simulation Center
Funding for this research was provided by the William Harmon Surgical Education and Research Fund.
Background
Central line associated bloodstream infections (CLABSI)s are well documented to negatively impact patient outcomes leading to prolonged length of stay, increased morbidity and mortality. As a result, multiple groups have published checklists for assessing procedural competence. Literature on central venous catheter (CVC) insertion. Deciding which of these tools to use in a local quality-improvement program is daunting, particularly given the lack of evidence as to the use of best practices in their development.

Objective
The goal of this review was to evaluate current literature on CVC checklist development in light of best practices to provide guidance on their local adoption and future development.

Methods
A literature search using PubMed was conducted to identify articles published from 2009-2018. Keywords included “Checklist” and “Central Venous Catheter”. Our initial search identified 106 unique articles. Two authors independently reviewed the studies with the following inclusion criteria: (a) complete description of the development and use of the CVC checklist tool, (b) focus: on technical skills for insertion (not maintenance), and (c) evaluation of procedural skills beyond sterile technique. Of 106 potential articles, 28 met inclusion criteria.

Coding Procedure: Two authors double-coded 50% of the articles. The code sheet included factors relating to checklist development and validation, including factors related to study design, validity evidence, and comprehensiveness of tool.

Results
The most commonly collected validity evidence was Standard Setting (32.1%), followed by Expert Consensus of Content (28.6%), and Rater Training (28.6%). None of the studies conducted usability testing. The average number of Subject Matter Experts (SMEs) involved in development was 4.06 ± 3.29. Almost all checklists were validated for use in a simulated environment only, and the number of assessment items ranged from 14-55. Only 6 studies focused specifically on generating validity evidence for creation of their checklist. Most studies (22/28) used a previously validated checklist, resulting in few unique tool development reports.

Conclusion
Few CVC insertion checklists in the literature were created using best practices in the development and application of procedural skills assessments. As almost all checklists were created for use in a simulation, applicability to a clinical environment may be limited. These data can guide institutions on their choice of a published CVC checklist for local quality improvement programs and encourage assessment scientists to create tools with more rigor.

Bibliography
Surgeons and Engineers: A Dialogue on Surgical Simulation
Images of posters received by participants
Poster Rounds Session Group E
Saturday, March 16, 2019
Surgeons and Engineers: The need for computer based simulation platforms for colonic endoscopic submucosal dissection (cESD)

Dickinson KP, Zajac S1, Bass BL1, Dunkin BJ1
1Department of General Surgery and Methodist Institute for Technology, Innovation and Education, Houston Methodist Hospital, Houston, Texas.

Objective
1. To detail the need for a computer based simulation of colonic endoscopic submucosal dissection (cESD) to promote dissemination of this skill.
2. To make simulation developers aware that we have generated the data required to develop a simulator
   - needs assessment,
   - deconstructed task list,
   - measures of performance,
   - an evaluation tool
   - pilot of the steps and assessment tool on a relevant wet lab simulation model
3. To partner with an Engineer group to share this information and create the platform.

Background
Using ESD to resect large benign and early-stage malignant colonic neoplasms has become the preferred treatment modality in parts of the world. The technique provides an en bloc resection with more accurate pathologic staging and lower local recurrence. Adoption of cESD in the West, however, has been limited given technical demands, risks of complications, and no readily available safe clinical construct for rehearsal (e.g., in Japan, mastering gastric ESD is a pre-requisite to learning the more difficult cESD). As a result, there is a need to develop an effective and accessible cESD simulator.

Methods
We developed a cESD curriculum by:
- Performing a needs assessment
- Consensus conference with industry and SME (subject matter experts)
- Job task analysis with SMEs to identify knowledge, skills, and abilities to perform cESD
- Deconstruction of SME steps based on SME semistructured interviews and modified Delphi process
- Creation of metrics and an assessment tool to measure performance of the deconstructed tasks
- Piloting of deconstructed tasks and assessment tool on a novel explant model

Results
We have produced a curriculum for cESD using a wet lab simulator in which practicing surgeons/endoscopists can learn this technique.

We have a comprehensive task list for cESD by which this can be taught on a simulated model

We have an assessment tool by which the learners competency can be assessed.

This curriculum is available in certain simulation lab settings and not easily accessible for learners to access at their home institution while incorporating cESD into their practice

We have established a need for a computer based cESD model to be locally available for learners

Conclusion
- We used rigorous science to generate the data required to inform what skills are required to perform ESD and how to measure those skills in a practitioner.
- This work has been piloted with success on a wet lab explant model
- In order to promote scale and distributed practice in training, a computer based simulation model is needed.

Didactic teaching as part of the cESD curriculum

Wet lab teaching of colonic ESD
ABSTRACT
High-fidelity simulation has been shown to provide invaluable learning experiences for a variety of different medical procedures. Currently, there are limited number of structural pelvic models that allow for realistic task training of obstetric procedures, including operative deliveries. Of the four pelvis types described in women (gynecoid, anthropoid, platypelloid, and android), the android occludes most commonly in women, yet the android configuration is the most prevalent type encountered in simulators. The common android model has a number of limitations that preclude its use in obstetric procedure simulations. One restriction includes an inadequate triangular anterior segment that prevents descent of fetal vertex or breech deep into the pelvic inlet. Another constraint encountered was inept two-point anchoring of the inferior bony pelvis which led to torque and fracture of the symphysis pubis while performing difficult extractions. Construction of a frame in which to reproduce the gynecoid bony pelvis, was undertaken to address the previously mentioned restrictions of the android pelvis. The pelvimetry of the original model was altered by increasing the oval transverse diameter of the pelvic inlet and increasing the subpubic angle. This increase in the circularity of the transverse ellipse of the pelvic brim will allow for the realistic simulation of the descent of the fetus into the mid pelvis and subsequent rotation into the vertex occipitoanterior position or breech presentation. Future applications for this prototype include constructing a common female mold, which will allow for widespread distribution of this gynecoid pelvis frame that can be used to practice simulated obstetric procedures in medical education and training.

METHODS
To construct the modified bony pelvis a variety of modifications were made to address the above mentioned restrictions of the current pelvis model, Strategic Operations’ Cut Suit TM PLUCBN. The PLUCBN is composed of a resin polymer and has a pelvic inlet dimension of 12.7 cm and subpubic angle of 50 degrees, with a 2 point posterior ischial stabilization system and prominent ischial tuberosities. To optimize the existing geometric configuration, the first step was addition of a wooden splint extension between the pubic rami at the pubic symphysis, resulting in an increase in pelvic inlet measurement from 12.7 cm to 14 cm. The frame of the pelvic model was then elevated to increase the antero-posterior diameter by 20% with shim extensions. This also increased the pubic arch angle from 50 degrees to 90 degrees. Next the pelvis frame was altered from a two point ischial stabilization to a 4-point stance to withstand the normal forces and torque exerted on the pelvis model during dynamic procedures such as cesarean delivery. Subsequent steps involved contouring the new frame, flattening the prominent ischial tuberosities and filling void areas thereby smoothing all surfaces of the model to prevent tearing of the uterine musculature and amniotic sac. The final modification sequence involved sealant and invariable paint to protect and solidify the polymer resin and to provide osseous realism.

CONCLUSION
Overall, the modifications applied to the PLUCBN pelvis model allowed for a realistic simulation of obstetric procedures including cesarean section. The enhanced pelvimetry addressed the areas of restriction including the inadequate antero-posterior diameter and the unstable two-point anchoring system of the frame of the bony pelvis. The expansion of the diagonal conjugate, increased subpubic angle, and increased transverse diameter of the pelvic inlet allowed for realistic simulation of the descent of the fetus into the mid-pelvis and subsequent expected rotation into the vertex position or breech position. By altering the bony pelvis stabilization configuration from a two-point to a four-point base, the pelvis model was able to withstand the significant force and torque exerted on a pelvis during obstetric procedures. Of note, this modification was undertaken after the pelvis model was tested in a simulated emergency cesarean section, which fractured and risked injury to adjacent organs such as the uterine fundus and bladder. Further sequelae from the fracture could include puncture into the amniotic sac, thereby compromising the integrity and reality of the entire exercise. After the initial simulation it was determined that the existing PLUCBN pelvic model did not allow for proper dispersal of the normal forces occurring in obstetric procedures. The pelvis model was then altered and re-tested in the same emergent operative delivery simulation. The modified PLUCBN pelvis was able to withstand the subsequent procedure unscathed, supporting the hypothesis that external forces generated by the narrowed inlet and the torque on the symphysis by the unstable frame were indeed the cause of the previously observed fracture in the original pelvic model. The developed modifications allowed for successful simulation of cesarean delivery including perimortem and multiple gestation cesarean delivery. Future applications for this prototype include constructing a common female mold, which will allow for widespread distribution of this gynecoid pelvis frame that can be used to practice simulated obstetric procedures in medical education and training.

REFERENCES
Correlating Laparoscopic Tool Path Length in Peg-Transfer Task with Surgical Residency Education Level

Kelsey Leonard1, Dustin Baker, MD2; Jacquelyn Pastewski, MD2; Pavan Brahmadam, MD3,5; Kathryn Ziegler, MD2,3; Victoria A. Roach, PhD1

1Department of Foundational Medical Studies, Oakland University William Beaumont School of Medicine, Rochester, MI
2Beaumont Health, Department of Surgery, Royal Oak, MI
3Department of Surgery, Oakland University William Beaumont School of Medicine, Rochester, MI

INTRODUCTION

• Assessment of fundamental laparoscopic skill has been based on variables such as time to completion or visual inspection of the task for evaluation of proficiency.
• Motion analysis provides a valid mechanism of assessment for laparoscopic surgical skills.1,2
• Yet motion-tracking data has not been leveraged as a means of providing useful feedback to surgical residents.2,4
• A customized laparoscopic box trainer has been developed and validated using the intracorporeal suturing task. The study was able to differentiate between novice, intermediate, and expert surgeon groups.3

OBJECTIVES

• To implement motion tracking analyses to assess how movement patterns in the path length of laparoscopic tools change with resident education level during a peg-transfer task.
• To determine feasibility of path length to discriminate between laparoscopic proficiency levels.

HYPOTHESES

• As learners progress through residency, they will display more economical motion with fewer extraneous movements when completing tasks.
• Total path length of tool movement through space will decrease as level of education and proficiency increases.

RESULTS

• Test population (n = 37): General Surgery Residents at the Royal Oak - Beaumont campus who volunteered to participate.
• Subjects completed a peg-transfer task using a customized box trainer.2
• Using an optical sensor,2 translation of each tool’s movement along the x-axis of the box trainer was recorded.
• Data were translated to length measurements and path lengths (sum of right and left laparoscopic tool length measurements) using MATLAB.
• One-way ANOVA and and Tukey’s HSD were employed to contrast path length across groups using SPSS statistical software package.

RESULTS (CONT.)

Figure 7. A more detailed view of each test group’s individual metrics of path length organized into box-and-whisker plots for simplified comparison.

CONCLUSIONS

• The peg transfer task teaches a fundamental laparoscopic skill that can be mastered by novice surgeons.
• Path length was longer for inexperienced residents relative to either of the more experienced groups.
• The more experienced groups had similar average path lengths.
• Path length during a peg-transfer task plateaus between PGY-3 and PGY-6.
• Path length may be pursued as a objective measurement of surgical skill proficiency.

REFERENCES

6. Dustin Baker, MD; Jacquelyn Pastewski, MD; Amy Someret, MD; Kelsey Leonard; Victoria Roach, PhD; Kathryn Ziegler, MD; Pavan Brahmadam, MD. Motion Analysis of General Surgery Residents Performing the Laparoscopic Peg Transfer Task and the Effect of a Secondary Task. Submitted to: SAES 2019 Annual Meeting; April 3-4, 2019, Baltimore, MD.
7. https://www.youtube.com/watch?v=ggcFBFHAp0Q

Figure 1. Visualization of Decreasing Path Length with Increasing Experience. As someone becomes more experienced in completing a task, we expect them to become more efficient in their movements.

Figure 2. Customized laparoscopic box trainer.

Figure 3.

Figure 4.

Figure 5.

Figure 6. A visual comparison of each test group’s individual distributions of its subjects’ path lengths. Note: The height of each curve is only relevant in reflecting the width of each group’s standard deviations.

Table 1. Residency year groupings.

<table>
<thead>
<tr>
<th>Group Definitions</th>
<th>Residency Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>PGY 1 &amp; PGY 2</td>
</tr>
<tr>
<td>Group 2</td>
<td>PGY 3 &amp; PGY 4</td>
</tr>
<tr>
<td>Group 3</td>
<td>PGY 5 &amp; PGY 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Results</th>
<th>Mean</th>
<th>SD</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>14</td>
<td>215.61</td>
<td>54.61</td>
<td></td>
<td>p = 0.05</td>
</tr>
<tr>
<td>Group 2</td>
<td>11</td>
<td>163.77</td>
<td>43.05</td>
<td></td>
<td>p = 0.05</td>
</tr>
<tr>
<td>Group 3</td>
<td>12</td>
<td>163.03</td>
<td>43.05</td>
<td></td>
<td>p = 0.999</td>
</tr>
</tbody>
</table>

Table 2. Summary of results. Group 1 had significantly longer pathlength when compared to Group 2 and 3 respectively.
Assessment of innate aptitude for surgery in unconditioned medical undergraduates
Andrea Moglia*, PhD, Vincenzo Ferrari, PhD, Luca Morelli, MD, FACS, Mauro Ferrari, MD, Franco Mosca, MD, FACS (Hon), Alfred Cuschieri, MD, FACS (Hon)

Background
Although ability for technical skills is not currently a component of the selection of surgical residents, there is a common belief amongst program directors to recruit preferentially candidates with the necessary level of innate ability for acquisition, on completion of training program, of the manipulative technical skills required by competent safe surgeons. The study assessed a large cohort of medical students for their innate level of innate psychomotor skills using a virtual surgical simulator.

Material
A group of 155 medical students, without prior experience of any kind of surgical simulators, executed five tasks (Peg board 2, Ring walk 2, Match Board 1, Ring and rail 2, and Thread the rings 2) on a virtual simulator for robot assisted surgery until reaching proficiency twice consecutively before moving to the next. A penalty was assigned each time a student was unable to complete a task or needed help from the tutor for successful execution. A weight was assigned to each task in terms of time and number of attempts to reach proficiency.

Results
Nine students (5.8%) outperformed all the others on median (i.q.r.) weighted time (44.7 (42.2-47.3) min versus 98.5 (70.8-131.8) min, p<0.001), and number of attempts to reach proficiency (14 (12-15) versus 23 (19-32.75)), with significant difference (p<0.001), and without penalties in any task. Seventeen students (11.0%) scored much worse than the rest on median weighted time (202.2 (182.5-221.0) min versus 84.3 (65.7-114.4) min, p<0.001), and number of attempts (42 (40-48) versus 22 (17.25-28)), with significant difference, p<0.001, and receiving 14 penalties for Peg board 2, three for Ring walk 2, two for Match board 1, 18 for Ring and rail 2, and seven for Thread the rings 2. Low correlation between simulator scores and extra-curricular activities, like videogames and musical instruments, was found.

Conclusions
The test successfully identified proficiency gain curves of three distinct groups: gifted individuals, those with average, and those with scarce level of psychomotor skills. Hence, a test on a virtual surgical simulator can be considered as a part of the selection process of surgical residents.

Reference

* Contact
Andrea Moglia
EndoCAS, Edificio 102
via Paradisa 2, 56124, Pisa, Italy
e-mail: andrea.moglia@endocas.org

Supported by
Fondazione Arpa
www.fondazionearpa.it

University of Pisa
Fundamental Surgery simulations achieve face validity in orthopedics and spine surgery

Authors: Peter Rainger*, Janis Railbots MD, Philip Pucher MD PhD BSc MRCs
Presenting Author: Peter Rainger, FLPI

ABSTRACT:

Fundamental Surgery has created a haptically-enabled virtual reality simulator that experientially educates orthopedic surgeons across a variety of critical orthopedic surgeries including total knee arthroplasty, posterior approach to total hip replacement, and spinal pedicle screw placement.

Exposure to detailed haptic surgical simulations is hypothesized to enhance surgeon knowledge and confidence leading to a shortening of the lengthy learning curve for these procedures.

Pilot studies involving 76 surgeons varying in their level of training occurred three times during orthopaedic conferences in England in 2018/19. Participants ranging from core trainee to consultant trialled the simulations to assess the validity of the simulations and provide feedback to aid in improving the educational platform.

At the conclusion of each participant’s use of a simulation, a questionnaire assessing their view of the simulation in terms of surgical confidence and face validity was completed. The results demonstrate very high positive ratings for increasing surgical confidence and face validity of the simulations by Fundamental Surgery.

INTRODUCTION:

Fundamental Surgery has placed, as it’s primary focus, the aim of making orthopedic surgery safer through haptic virtual reality simulator-based learning.

Since 2018, Fundamental Surgery has created haptic virtual reality simulations for total knee arthroplasty, posterior approach to total hip replacement, and spinal pedicle screw placement.

Pilot studies were undertaken at three orthopedic conferences in England with 76 surgeons ranging from core trainee to consultant trialling the simulations and the validity of the simulation and provide feedback to aid in improving the educational platform.

At the conclusion of each participant’s use of the simulation, a questionnaire assessing their view of the simulation in terms of face validity and product value was completed. The results demonstrate very high positive ratings for both face validity and product value of the orthopaedic simulations by Fundamental Surgery.

RESULTS:

Confidence

All participants felt that the simulations were a useful training tool for surgeons and that regular use of the simulation would improve surgical confidence (overall average 6.1 out of 7).

The development of trainee confidence is an important factor in their surgical efficiency and efficacy. 91% of participants agreed or strongly agreed that regularly using the simulator would improve their confidence in active contributions in surgery (Fig 1). 74% agreed or strongly agreed that regular simulator use would improve their surgical performance, while 72% agreed or strongly agreed that regular use would help prevent surgical errors.

Simulation Face Validity

Face validity can be defined as an extent of a simulation’s realism and appropriateness to the actual task. To evaluate the face validity, participants evaluated the visual quality, experience, anatomical correctness, and procedural flow of the simulation (Fig 2).

90% of participants agreed or strongly agreed that the simulation presented a high-quality visual representation of the procedure and 90% agreed that the simulation provided a valuable learning experience. 82% agreed or strongly agreed that the anatomy within the simulation was realistic to patient anatomy and also that the procedural flow was realistic to that experienced in real surgeries.

CONCLUSION:

In summary, this pilot study demonstrated that the orthopedic haptic VR surgical simulations by Fundamental Surgery provides a valid surgical training environment. Our findings suggest that this type of platform can enhance the surgical confidence of the surgeon who regularly uses the simulation.
Simulated Surgical Robot Trainer for Surgical Assistants
Naveen Kumar Sankaran1, Kuoceng Wang1, Kevin J Pommier1, Menglin Tian1, David L Crawford, MD2, Thenkurussi Kesavadas, PhD1
1Industrial and Enterprise Systems Engineering, Health Care Engineering System Center, University of Illinois at Urbana-Champaign, Urbana, IL, USA. (Email: msankaran2, kwang082, mtiang01, kcrawford@uiuc.edu).
2Department of Computer Science, Health Care Engineering System Center, University of Illinois at Urbana-Champaign, Urbana, IL, USA. (Email: mtian0614@illinois.edu).
3Department of Surgery, University of Illinois College of Medicine at Peoria, Peoria IL, USA. (Email: dcrawford@peoriaasurgical.com)

ABSTRACT
➢ Task performed by surgical assistants in a robotic operation requires training and rehearsal to accomplish task in a safe and efficient way in an operating room.
➢ Surgical assistants (such as scrub technician, circulating nurse, fellows, residents and medical student) are given limited training despite performing critical tasks, thus risking patient safety.
➢ We present a simulation trainer application for surgical assistants exploring both Virtual Reality (VR) and Mixed Reality (MR).
➢ In addition to the interactive VR training in simulated environment, a MR 360-degree tutorial video is incorporated as part of training curriculum.
➢ Potential of simulator trainer application are successfully demonstrated with the da Vinci™ surgical robot along with a real procedure called Nissen fundoplication.

INTRODUCTION
➢ Robotic assisted operations are cooperative team tasks.
➢ Involves numerous members like surgeons, scrub nurses, circulating nurses, fellows, residents and medical students.
➢ Training surgical members are crucial to eliminate the risk of handling the robot in a way that could endanger the patient.
➢ Surgical robots need advanced setup and preparation in a sterile environment before the patient can even be wheeled into the OR.
➢ Limited hands-on training (limited due to expensive training process) will be insufficient as tasks performed by assistants vary between procedures, patients, and physician at the master console.

METHODOLOGY
Analysis of Surgical Robot Simulator Requirements
➢ Robot is configured near the patient by the surgeons and medical staff as a team.
➢ Robot setup procedure involves gross robot positioning.
➢ Robotic arm manipulation for desired configuration near patient.
➢ Robot setup configuration might vary based on many parameters such as patient anatomy, procedure, surgical location, and access direction.

Approach

<table>
<thead>
<tr>
<th>VR MODULE</th>
<th>MR MODULE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interact, practice, perform task</td>
<td>Observe, learn, respond questionnaires</td>
</tr>
<tr>
<td>Robot functionality</td>
<td>360 degree Video Training</td>
</tr>
<tr>
<td>Usability</td>
<td>OR setup &amp; Sterile field</td>
</tr>
<tr>
<td>Robot manipulation &amp; configuration</td>
<td>Precautions &amp; Troubleshooting</td>
</tr>
<tr>
<td>Dynamic audio responder</td>
<td>(User instruction) Surgeon in 360 video</td>
</tr>
</tbody>
</table>

Figure 1. Learning components of surgical robot trainer
➢ Robot positioning training is provided on a HTV Vive head mounted VR system.
➢ HTC Vive controller is used for Interactions (grab, teleport, manipulate, etc.).
➢ Orientation module has been provided to teach the trainees how to use the controller.
➢ User performing the robot manipulation task (aligning the robot near patient bed) and the robot arm configuration-setting task (aligning the robot arm).

RESULTS
Virtual Reality Training Module
Figure 3. User interacting with robot performing manipulation task using HTC VIVE controller (left). User performing robotic arm configuration task (right).

Figure 4. Robotic system configuration & manipulation training in VR module

Mixed Reality Training Module

Mixed Reality Robotic Surgery Trainer
A brief demonstration of a robotic surgery investigatory curriculum
1. Console Introduction
2. Sterile field setup
3. Patient Preparation
4. Robot setup near patient
5. Procedure Tool Changing Task
6. Fundoplication procedure

Figure 5. MR training modules- Nissen fundoplication procedure with the da Vinci robot

Figure 7. Mixed training module with Assessment questions for user

Figure 6. Screenshot of user’s first-person view 360-degree video showing robotic Nissen fundoplication procedure MR application, with real with an enhanced graphic showing the procedure planning for better observation.

CONCLUSIONS
➢ The simulated surgical robot trainer was successfully developed and demonstrated with integrated VR and MR module.
➢ An actual robotic Nissen fundoplication procedure with the da Vinci robot is presented and this will be extended to numerous other robotic procedures.
➢ With an extensive format learning curriculum and knowledge of the procedures and constructive assessment, the surgical staff can be trained for robotic procedures in an affordable and safe environment outside the OR.
➢ Software can be extended to other procedures and medical devices to provide a unique low-cost training.
➢ Future plan for this project is to conduct a content validity study with IRB approval to evaluate the learning content of this simulation trainer.

ACKNOWLEDGEMENT
We would like to thank Jump ARCHES endowment through UIUC Healthcare Engineering Systems Center and Jump Simulation Center at OSF Healthcare for supporting this project.